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ABSTRACT

This paper describes a pilot program at the City University of New York Brooklyn College which pairs an English as a Second Language (ESL) reading and writing class with a Calculus I class. The class focuses on students' language development but makes use of themes, readings, and vocabulary from calculus. This model requires coordination before and during the term between the language and calculus teachers. Students are provided with enriched, intensive instructional teams who meet their curricular requirements. The school uses block scheduling for students in their first two semesters of college to help ensure success. Students are placed in a block of classes and travel with the same people from class to class in the enriched environment. The ESL/mathematics class meets 6 hours per week, and students who register for it must have both the appropriate ESL placement and math prerequisites. A glossary of English words commonly used in math is available for students enrolled in the integrated classes. (Contains 17 references.) (SM)

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Mathematics and the ESL Student

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Abstract

We describe a pilot program pairing an English as a Second Language reading and writing class with a Calculus I class. Theoretical and practical pedagogical issues are discussed.

Rationale for Linking Language and Content Instruction

Recent surveys show that almost half of all City University of New York (CUNY) students come from homes where a language other than English is spoken, and that 15 to 20% of entering freshmen register for English-as-a-second-language (ESL) courses. This phenomenon is by no means particular to CUNY; indeed, the number of second language students is rising dramatically across the United States.

Generally, there have been two broad approaches to attempt to meet these students' needs. The first approach has consisted of requiring the students to complete an ESL-only program before being allowed to matriculate as regular college students, while the second approach has sought to integrate language and content instruction.

While the first approach ("take care of the problem in ESL before the students are allowed into the mainstream") holds a strong intuitive appeal for many, the research in second language acquisition over the past two or more decades suggests (a) that reaching grade-level norms in the schools can take from four to eight years and (b) that second language acquisition often proceeds more successfully when the instruction is focused on academic content rather than linguistic form, when the instructional language is made accessible to the students, and when the instructional atmosphere is relatively stress-free. Thus, in order not to delay the academic progress of second language students while simultaneously providing them with the opportunity to develop their academic language skills, there has been a growing recognition of the need to link ESL and content courses.

In practice, the attempt to link content and language instruction has taken many forms including the following:

- bridge courses: these are theme-based ESL courses designed to prepare students for specific content courses. Such courses typically employ readings and vocabulary which will be covered in the content area course.

- sheltered courses: these courses are focused on academic content but designed specifically for ESL students. The

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curriculum is adapted to meet students' language needs and the course may be taught either by an ESL teacher with an additional specialization in a content area, or by a content area teacher with training in ESL techniques. Unlike a bridge course, the sheltered course does not act as a pre-requisite for a content area course but rather as a substitute.

- paired courses: the same group of students attends both a specific ESL course and the content course with which it is paired or linked. The ESL course will focus on the students' language development but make use of themes, readings and vocabulary from the content area course. The ESL teacher needs to learn the material of the content course and develop teaching materials based on it. The content area course will focus on traditional academic concepts, but the instructor will seek to incorporate instructional techniques such as:

- selection of well-written and clear texts
- presentation of adequate visual reinforcement
- use of study guides, outlines and glosses
- assignment of appropriate reading and writing tasks
- willingness to allow rewriting of papers

This model requires thorough coordination before and during the term particularly between the language and content teachers but also with the administrative staff (and tutors, if any are involved).

- blocked courses: this approach is similar to the paired approach but involves more than two courses. For example, the same group of students might take an ESL writing/reading course, an ESL speech course and two content area courses. The instructors involved will then decide which content materials to adapt for the ESL classroom, but otherwise the process is essentially similar to the paired approach.

When effectively carried out, the paired or blocked course approaches a promising avenue for providing ESL students with the opportunity to make effective progress both in their academic development and in their second language proficiency.

Block Programming at Brooklyn College

For a number of years, Brooklyn College's Office of the Dean of Undergraduate Studies has created blocks as part of CUNY's freshman experience programs. Although blocks were originally created for incoming students who failed one or more of CUNY's Skills Assessment Tests (reading, writing, or math), they are now scheduled for all freshman and even extended to the first two semesters rather than only the first to ensure greater success for first year students.

Students are placed into a block of courses (for example, an integrated ESL reading and writing course and a section of a mainstream college course such as Art History, Classics, or CIS). Usually the same students are in all sections of a block, thus

increasing their sense of community. Since students who report speaking a language other than English at home are expected to soon represent 50% of CUNY's entering freshman, such blocks were initiated by the college to address their needs and have evidenced higher retention rates. The Freshman Year Program course pairings offer enriched, intensive instructional team models and meet the curricular requirements of this population. ESL students have programmatic and financial needs for credit-bearing courses. Students barred from college courses perceive ESL programs as barriers rather than aids. ESL students in CUNY have been found to do well in academic courses despite their lack of native proficiency in English. Thus, a Math/ESL pair would address students' skills needs, credit needs, and provide an integrated base for their future goals: to succeed in core curriculum and advanced academic courses.

Blocks also appear promising in terms of the number of students progressing through and/or exiting ESL programs. At Brooklyn, there has been a higher pass rate (one study found a 47.5 % rate vs. 34.5%) on the Writing Assessment Test (WAT) than in traditional ESL courses. Such data were used to design a one-year ESL model to meet new limits on ESL and remedial instruction within senior colleges of CUNY because it is believed blocking will best support and increase students' opportunities to develop and progress in English proficiency.

Block programming also benefits faculty who teach in such courses. It promotes faculty exchange and development of pedagogical strategies. Instructors collaborate and coordinate materials and/or activities, thus reinforcing each other's work with students. Although faculty coordination remains problematic without release time for faculty (especially part-timers) in a block to meet, those who do meet or at least speak by telephone share information about course goals, texts, student assessment and performance.

Implementation of a Calculus I/ESL block and Student Assessment

In addition to the reasons for linking ESL courses to content courses in general there are a number of reasons why the content course should be mathematics. Many ESL students gravitate towards mathematics and towards fields where mathematics is essential - such as the physical sciences, computer science, engineering, business and economics - because they assume that their language deficiencies will not handicap them as much as they would in other fields. They believe that the necessary level of English proficiency is lower in the study of mathematics because of the symbolic nature of the subject. They anticipate few reading and writing assignments. Moreover many of the ESL students have a strong mathematical foundation from their native country and wish to expand their mathematical experience. College advisors tend to steer ESL students into mathematics courses for the same reasons. Because of the large number of ESL students in

mathematics classes, it makes sense pedagogically and practically to provide special support for them.

The current mathematical reform movement provides another impetus for pairing ESL and mathematics courses. A common thread in the movement is the communication of mathematics via reading, writing and speaking. It is well documented that communicating mathematics promotes a deeper and more lasting understanding of the subject. Incorporating mathematics into everyday language and experiences motivates and facilitates students' learning. Thus direct pairing of ESL reading, writing and speech courses would encourage and support an enhanced instructional environment in the mathematics courses.

We are currently planning to add a calculus I - ESL block to our program at Brooklyn College. The ESL part of such a block will be directed at students on the high intermediate or advanced level of English. The course will be integrated (reading, writing, speaking and listening) to eliminate artificial divisions and allow for more efficient development in all areas. It will meet six hours per week. Students who register for it will have to have both the appropriate ESL placement and math pre-requisites. The calculus section may be half ESL and half native speakers or be made up of two sections of an ESL course. In the ESL course, students can more actively discuss mathematics information, explain problems in groups, share knowledge, check understanding (a form of comprehension monitoring), maximize use of English, and lessen their social isolation on the campus.

The language of mathematics is concise and precise. It is a hi-density language expressed with few redundancies. These characteristics help attract ESL students to Math courses but they also pose difficulties. The lack of redundancy requires students to understand the material the first time. An exact understanding of the language is essential to the comprehension of the subject. The definition of logical connectors (such as if/then, either/or, if and only if, and therefore) often proves crucial. Moreover, a single concept are often expressed in several different ways. For example "1/2 n" can be expressed as "n divided by 2", "1/2 of n", "n over 2", or "1/2 times n."

A glossary of English words commonly used in the math will be prepared for the math courses. They will include three categories of words:

- mathematical words that students learn during their elementary and high school years. Examples of such words are "quotient", "ratio" and "area"
- English words which take on a more specific meaning in mathematics. Examples of such words are "limit", "increasing and decreasing functions"
- non-mathematical words that frequently appear in verbal problems. Examples of such words are "velocity" and

"acceleration."

The glossary will be provided to the students and to the ESL instructors. Its content will be integrated into the ESL courses. Readings containing words from the glossary will be used by the ESL instructors. In linking their classes with mathematics, ESL instructors can use some general introductions to topics and chapters from the mathematics texts as reading material. Some of the students' writing assignments can be based on their math course as well. They can write an essay at the beginning of the semester explaining why they are studying mathematics and what they expect to learn. They can summarize certain topics - for example max-min and related rate problems. They can read and reword verbal problems and make up new verbal problems of a given type.

In thinking, processing information, and formulating both spoken and written responses together, students gain confidence and competency in English and mathematics. They are more likely to participate in lecture courses and retention in both English and Math is increased. English and Mathematics are foundations for the rest of their work in college and often their professional futures.

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